REMARKS

The present invention is directed to a polycrystalline alumina arc tube with a capacity of having a high light transmittance of 94% or greater while still using a sufficient amount of magnesium oxide to restrain any abnormal grain growth and maintain a uniform grain growth of alumina when sintered at a high temperature. As noted on Page 17, Line 20 through Page 18, Line 17, our present inventors are capable of providing a sintered alumina that was not tainted with a brownish or yellowish color but rather had an opal color capable of a high light transmittance and on Page 20, Lines 22-23, it is desirable to add at least 1 PPM of magnesium oxide to restrain the abnormal grain growth.

In addition, the present invention provided an appropriate tube wall loading factor, shown in Figures 4 and 5 to inhibit any cracking of an arc tube during its service life.

The prior art had recognized that sintered alumina powder could be subject to an abnormal grain growth. Abnormal grain growth is a phenomenon in which a grain grows extremely large in some areas, thereby impairing uniform grain growth. As a conventional method to avoid abnormal grain growth, MgO is added to alumina and a Hot Isostatic Pressing (HIP) is employed in the sintering of the alumina. In an HIP process, an object is heated while high pressure is simultaneously applied. Normally, gas such as argon is used as a pressure medium, and isotropic pressure is applied to the object. With this method, however, it is impossible to obtain sufficient light transmittance for a high quality ceramic bulb. This has been acknowledged as a problem.

In view of this problem, the present invention provides a high performance lamp by defining an arc tube made of polycrystalline alumina ceramic that has been sintered under ordinary pressure (of a hydrogen atmosphere) or under a vacuum and has a crystal grain diameter

within a predetermined range for the alumina sintered ceramic, an adequate tube wall loading, and a ratio of the distance between the electrodes and the inner diameter within predetermined ranges, so that the polycrystalline alumina ceramic has light transmittance of 94% or more.

The Office Action rejected Claim 12 as being completely anticipated by *Nagayama* (U.S. Patent No. 5,742,123).

To a person of ordinary skill in this field, the *Nagayama* reference sought to solve a specific problem of thermal stress in a bulb assembly, and more particularly, tried to eliminate thermal stresses in a sealing of a closure by a gradual modification of a coefficient of thermal expansion. The Office Action cited the teaching of Column 16, Lines 6-25 as follows:

> Since the bulb 1F according to this embodiment is made of light-transmissive alumina composed of small crystal grains having an average particle diameter of about 0.7 μm and a maximum particle diameter of about 1.4 μm and <u>does not form any grain boundary phase</u>, the mechanical strength (bending strength, Weilbull coefficient) in a range from room temperature to a temperature upon discharging <u>is higher than a general bulb assembly of light-transmissive ceramics which are produced by firing alumina with a sintering additive of MgO</u> or the like for greater crystal grains. As a result, the light-emitting bulb assembly with the bulb 1F according to the present embodiment has a reduced wall thickness as well as an increased service life. Inasmuch as the reduced wall thickness lowers the thermal capacity of the light-emitting bulb assembly, allowing the light-emitting bulb assembly to be heated quickly to a desired temperature, the starting time required for the discharging metal component to be evaporated up to a saturated vapor pressure until energization of the bulb assembly becomes stable is shortened. (underline added)

As can be appreciated this teaching, to a person of ordinary skill in the field, would <u>teach away</u> from a bulb assembly for a light transmissive ceramic bulb that was made by <u>firing alumina with a sintering additive of MgO</u>.

As taught at Colum 10, Line 57 through Column 11, Line 3,

> The completed bulb 1F made of light-transmissive alumina has smaller crystal grain diameters than general light-transmissive ceramics which are produced by firing alumina with a sintering additive of MgO or the like for greater crystal grains (see FIG. 2).
>
> The bulb 1F fabricated from <u>highly-pure alumina</u> has a light-transmitting ability while having small crystal grain diameters different from those of general light-transmissive ceramics for the following reasons:
>
> Since only a small amount of oxide such as MgO or the like mixed <u>as an impurity</u> (a total of 0.01 mol % or less at maximum) is contained in the powder of alumina, the <u>impurity forms in its entirety a solid solution with alumina, producing almost no grain boundary phase</u>. (underline added)

Thus, if any magnesium oxide was present, it was considered to be an impurity contained in the powdered alumina to such an extent that it would not even provide or produced any meaningful grain boundary phase.

While the present invention wishes to limit the amount of magnesium oxide, it clearly calls for a ceramic tube part "having magnesium oxide of 200 PPM or below." This is supported by our specification.

Accordingly, the *Nagayama* reference teaches away from our claimed invention.

> A prior art reference must be considered in its entirety, i.e., as a <u>whole</u>, including portions that would be lead away from the claimed invention. *W.L. Gore & Associates, Inc. v. Garlock, Inc.*, 721 F.2d 1540, 220 USPQ 303 (Fed. Cir. 1983), *cert. denied*, 469 U.S. 851 (1984).
>
> MPEP 2141.02 VI

The *Nagayama* reference was cited for a contention that the average particle diameter of the crystal grain would be 0.7 μm and that the maximum range, or maximum particle diameter would be 1.4 μm.

However, although the average crystal grain diameter and the maximum grain diameter are defined in the *Nagayama* reference, a minimum crystal grain diameter is not defined in these teachings.

As the average crystal grain diameter could be 0.7 μm and the maximum crystal grain diameter is at most 1.4 μm, the grain diameter can be less than 0.54 μn. Thus, it is clear that the *Nagayama* reference does not meet the requirement "crystal grain diameter G (gym) satisfies 0.5<G<1.5" of the present invention.

Further, although the *Nagayama* reference describes a "linear transmittance" (e.g. Column 10, Lines 53-56) of the polycrystalline alumina ceramic, it does not disclose a "light transmittance" in the context of the present Application is 94% or more. It should be noted here that the term "transmittance" in the context of the present Application is different from a "linear transmittance." This is clear from Page 25, Line 14 of the Specification of the present Application, where the "transmittance" is defined in distinction from a "linear transmittance."

The "transmittance" (so-called total transmittance) of the polycrystalline alumina ceramic in the context of the present Application can be obtained with use of so-called "integrating sphere," in the following manner:

(Total flux of a light source covered with the polycrystalline alumina ceramic) /

(Total flux of the light source) X 100 [%]

The total transmittance with respect to the visible wavelength range (380 nm - 780 nm) does not have dependency on the wavelength (for reference, experiment data of the total transmittance of the polycrystalline alumina ceramic is attached hereto. In the graph, the horizontal axis shows the wavelength and the vertical axis shows the transmittance).

On the other hand, linear transmittance has dependency on the wavelength, and shows different properties from the total transmittance in the context of the present Application.

Moreover, although the ceramic of the *Nagayama* reference is fired with use of a Hot Isostatic Pressing method (Column 9, Lines 34-37), an alumina ceramic that is highly

transmissive and extremely fine as $0.5 \leq G \leq 1.5$ shows, can be obtained only under unique conditions with an alumina powder to which MgO has been added before sintering under an ordinary pressure (of a hydrogen atmosphere) or under a vacuum.

Since the *Nagayama* reference uses the sintering method of the type described in the "Background Art" of the present Application, it is impossible to achieve sufficient light transmission even if it is possible by chance to achieve the average crystal grain diameter 0.7 μm (the maximum crystal grain diameter: 1.4 μm). Please see the section "4. Method of sintering Alumina" in our Specification (starting at Page 14, line 21).

Thus, the present invention is completely different from the *Nagayama* reference in both structure and effects. The structure disclosed in the *Nagayama* reference cannot solve the problem that the present invention solves.

Claims 1, 3, 5-6 and 8-11 were held to be obvious over a combination of *Keijser et al.* (U.S. Patent No. 6,300,729) in view of the *Nagayama* reference.

The *Keijser et al.* reference did not address nor teach 200 PPM or lower amounts of magnesium oxide, nor an average crystal grain diameter of polycrystalline alumina ceramic of one desired size. Basically, a person of ordinary skill in this field would realize that the *Keijser et al.* reference was directed to providing a halide lamp having a capability of an increased lamp voltage by filling a lamp with not only sodium and mercury halide but also by introducing thallium, dysperium and cerium halides, see Column 3, Lines 8-10 as disclosed in the various possible embodiments for varying the ratios of halides.

The Office Action does not provide any reason why a person presented with the *Keijser et al.* reference, along with the total teaching of the *Nagayama* reference (where magnesium oxide is treated as an impurity).

In distinction, the present applicant recognized the necessity of intentionally adding magnesium oxide with alumina so that abnormal grain growth could be avoided at high sintering temperatures. See our Application, page 17, Lines 3-10.

Applicant further experimented with various types of furnaces before determining that a tungsten furnace would provide an adequate crystal grain, see our Specification Page 18, Lines 10-17, and further tested the life cycles of our resulting lamps to determine an appropriate relationship to produce the desired luminous flux relationship to the magnesium oxide concentration. See Figure 3 and Page 19, Line 11 through Page 21, Line 11 of our Specification.

In comparison, the principally relied upon *Nagayama* reference would teach to a person of ordinary skill in the field that magnesium oxide was simply a "impurity" and further, that the actual teaching of any mix for creating a ceramic bulb is to use a power of a highly pure alumina and mixing it with an acrylic thermoplastic resin with an organic solvent. See Column 8, Lines 24-38.

As can be readily determined, there is no intentional use of MgO. This compound is then injection molded into a molded body shape as shown in Figure 1 and then heated so that the organic binder of the acrylic thermoplastic resin is thermally decomposed and fully carbonized. Subsequently, the molded body with the carbonized binder is heat treated between 1200°C to 1300°C and prepared for a subsequent high hot isostatic pressing.

A person of ordinary skill in this field would appreciate that the primary teaching of the *Nagayama* reference is actually the novel closure for the ends of the ceramic bulb where layers of a combination of tungsten and alumina were prepared and applied so that a gradient of a coefficient of thermal expansion is provided through the use of a laminated body that is subsequently fired to produce the desired gradient thermal expansion range.

As can be appreciated, any combining of the teaching of these two references appears to have resulted in hindsight because of applicant's present disclosure. Applicant developed the claimed invention as a result of numerous engineering design tradeoffs such as the size of the arc tube and the concentration of magnesium oxide which have a mutual effect on the change in luminous flux of the lamp over time.

Applicant changed the magnesium oxide concentration because of its potential to effect other design variables in unpredictable or unexpected ways. Additionally, extensive life cycle testing was necessary to refine and realize the present invention as set forth in our claims.

In summary, the *Nagayama* reference teaches away from magnesium oxide and treats it as an undesirable impurity. As such, there would be no teaching to a person of ordinary skill in the field to modify the *Keijser et al.* disclosure.

> The [district] court acknowledged that the Supreme Court in *KSR* approvingly cited *United States v. Adams,* 383 U.S. 39, 51-52 (1966), for the "principle that when the prior art teaches away from combining certain known elements, discovery of a successful means of combining them is more likely to be nonobvious." 127 S. Ct. at 1739-40.
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> *Anderson Corp. v. Pella Corp.*, No. 2007-1536, slip op. at 10 (Fed. Cir. Nov. 19, 2008).

Our independent claims specifically call for the inclusion of a magnesium oxide with a polycrystalline alumina having a light transmittance of 94% or more.

Neither the *Keijser et al.* nor the *Nagayama* references disclose the following features:

"a polycrystalline alumina ceramic sintered under ordinary pressure of a hydrogen atmosphere or under vacuum"; "crystal grain diameter G (μm) satisfies $0.5 \leq G \leq 1.5$"; and "the polycrystalline alumina ceramic has light transmittance of 94% or more."

It is believed that the present application is now in condition of allowance and an early notification of the same is requested.

If the Examiner believes that a telephone interview will assist in the prosecution of this matter, the undersigned attorney can be contacted at the listed phone number.

Very truly yours,

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